

Review of the genus *Phocoderma* Butler, 1886 (Zygaenoidea: Limacodidae)

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Abstract. The genus *Phocoderma* Butler, 1886 is reviewed. Three externally similar species have been associated with the genus so far; the synonymy of *P. velutina* (Kollar) and *Natada rugosa* Walker is verified and a new species, *P. witti* sp. n., is described (type locality: Myanmar, 21 km E Putao, Nan Sa Bon village, 550 m; holotype in Museum Witt Munich, Germany). The three recognized species differ in male genitalia and in several newly found external characters.

Zusammenfassung. Die Gattung *Phocoderma* Butler, 1886 wird revidiert. 3 sehr ähnliche Arten wurden bisher in der Gattung beschrieben. Die Synonymie zwischen *P. velutina* (Kollar) und *Natada rugosa* Walker wird bestätigt und eine neue Art, *P. witti* sp. n., wird hier beschrieben (Typusort: Myanmar, 21 km E Putao, Nan Sa Bon village, 550 m; Holotypus im Museum Witt München, Deutschland). Die Arten unterscheiden sich deutlich in den männlichen Genitalien; auch einige neue Unterscheidungsmerkmale werden im Habitus festgestellt.

Резюме. К настоящему времени известно только два вида рода *Phocoderma* Butler, 1886, внешне очень похожих. В результате этого исследования была подтверждена синонимия между видами *P. velutina* (Kollar) и *Natada rugosa* Walker и описан новый для науки вид *P. witti* sp. n. (типовая местность: Myanmar, 21 km E Putao, Nan Sa Bon village, 550 m; голотип хранится в Museum Witt Munich, Germany). Виды рода *Phocoderma* Butler, 1886 хорошо отличаются друг от друга особенностями строения гениталий самцов, но также были найдены внешние диагностические признаки.

Introduction

Phocoderma Butler (1886: 4) was described as monotypical with type species *Gastropacha velutina* Kollar (1844: 473). By 1886 two species names were associated with the genus – *velutina* and *rugosa* Walker, 1855, both from the Indian region; they were synonymized by Butler (1886). In 1896 Druce (1896: 236) described a new species, *P. betis*, from South-West China. Since that time the genus was believed to contain only two these species (Hering 1931: 720).

As a result of this review, three valid species differing in male and female genitalia, characters of the labial palp and forewing pattern are recognized. The previous synonymy of *P. velutina* and *Natada rugosa* Walker was re-evaluated in the context of newly found characters. All characters usable for species identification are illustrated and distribution maps are given for each species.

Material and methods

This work includes a study of the type material of all species-level names associated with genus *Phocoderma* to verify their status. The female holotype of *Gastropacha velutina* was examined at the NMW (see list of abbreviations below), the types of both *Natada rugosa* Walker and *Phocoderma betis* Druce were studied at the BMNH. Also, numerous additional specimens were studied to analyze the geographical distribution

of all taxa and to test characters that might be usable for identification. Moths kept in the MWM formed the basis of this study; but material from ZSM, ZISP, NSMT, and BMNH was also considered, totaling approximately 200 specimens.

Genital slides were prepared and stained using the method of Hardwick (1950), the vesica was inverted, and the genitalia were mounted in Euparal. The moth images were taken with a Nikon Coolpix 5400 E digital camera and the images of genital structures were taken through a MBS-10 binocular microscope and later re-worked using Corel Photo Paint 11.

In the species descriptions below the ratios concerning labial palps always include scale covering.

Abbreviations

BMNH	The Natural History Museum; London, Great Britain
GU	genital preparation
MWM	Entomological Museum Thomas J. Witt; Munich, Germany (to be transferred to ZSM)
NMW	Naturhistorisches Museum Wien; Vienna, Austria
NSMT	National Science Museum (Natural History); Tokyo, Japan
ZISP	Zoological Institute of Russian Academy of Sciences; St. Petersburg, Russia
ZSM	Zoologische Staatssammlung der Bayerischen Staaten; Munich, Germany

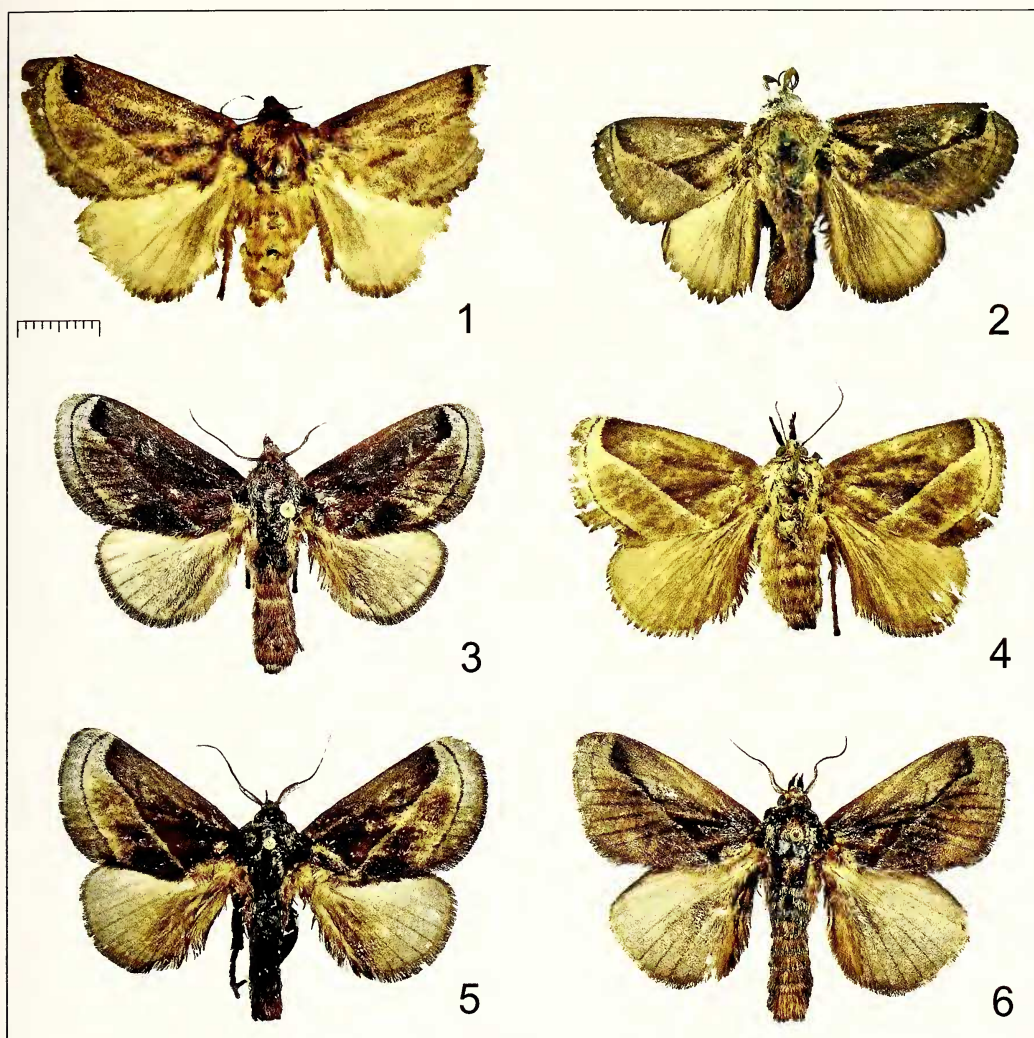
Results

Phocoderma Butler, 1886

Phocoderma Butler, 1886: 4. Type-species: *Gastropacha velutina* Kollar, 1844: 473.

Diagnosis. All species very similar in appearance and among the largest limacodids of the Oriental Tropics with wingspans of 51–72 mm (Figs 1–6). Ground colour various shades of brown. Body stout. Antennae bipectinate in male and filiform in female. Labial palps directed anteriorly (Figs 7–12). Proboscis vestigial, as long as first segment of labial palps, and spiraled in 1.5 turns. Foretibia with white distal patch. Species without sexual dimorphism, but females usually larger than males and more robust, with stouter body. Forewing elongate, with curved darker submarginal fascia parallel to external margin, and area basal to this divided by oblique line with subapical curvature. Venation identical in all species, conforming to ground plan of Limacodidae but with several diagnostic features (Fig. 13) (Holloway 1986: 100): forewing with medial stem branched distally; Sc slightly sinusoidal, A1+A2 with basal fork and with 6 pseudoneuria (or vestigial veins) from common stem of anal vein to lower margin of wing; R3+R4 stalked from R5. Hindwing with short oblique crossvein between Sc+R1 and Rs.

Male genitalia (Figs 14–20). Complying with limacodid ground plan (sensu Holloway 1986: 50); uncus simple, strong, wide basally, apically narrow; gnathos strong, curved at right angle medially; valvae without saccular process; transtilla interrupted medially (“hemitransilla” of Stekolnikov & Kuznetsov 1981: 536) present;



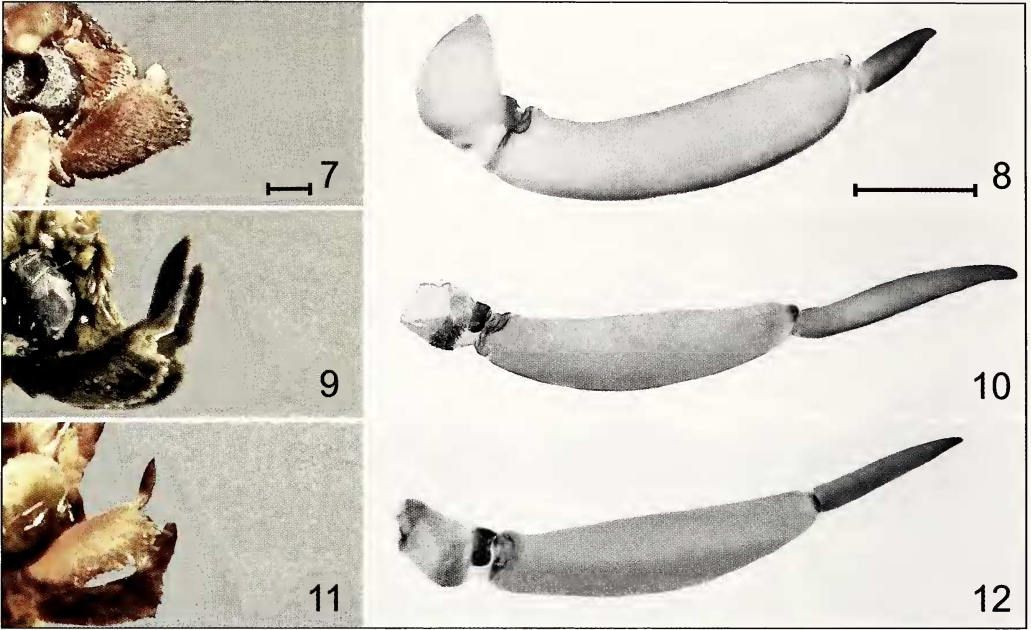
Figs 1–6. *Phocoderma* spp. 1. *P. velutina* (Kollar), holotype, ♀ (NWM). 2. *P. velutina* (Kollar), holotype of *Natada rugosa* Walker, ♂ (BMNH). 3. *P. velutina* (Kollar); Borneo, Selatan, ♂. 4. *P. betis* Druce, holotype, ♀ (BMNH). 5. *P. betis* Druce; China, Simao, ♂. 6. *P. witti* sp. n., holotype, ♂ (MWM). Scale bar: 1 cm.

phallus very long, mostly straight, with characteristic dorsoapical process of variable shape; juxta flattened, ellipsoidal (Fig. 14).

Female genitalia (Figs 21–30). Both pairs of apophyses well developed, apophyses posteriores 1.5 times longer than anteriores, as long as height of ovipositor lobes (Figs 21, 22); antrum strongly sclerotized, much broader than ductus bursae, curved; ductus bursae very long, spiraled; corpus bursae ovoid, with paired signum.

Larva. Of the “nettle” type, as described below in specific account of *P. velutina*.

Remarks. The genus consists of three species, one of them being described here as new. All three are very similar in appearance, but easily distinguished from one



Figs 7–12. Labial palps of *Phocoderma* spp., ♂♂. **7.** *P. velutina* (Kollar); Indonesia, Aceh (Sumatra). **8.** The same without covering scales; Malaysia, Sabah (Borneo). **9.** *P. betis* Druce; China, Shaanxi. **10.** The same without covering scales. **11.** *P. witti* sp. n., paratype; India, Assam. **12.** The same without covering scales; paratype; Myanmar, Putao District. Scale bar: 1 mm.

another by genitalic characters, especially by the shape of the apical process of the phallus. External diagnostic characters are also available: the ratio between the 3rd and the 2nd segments of the labial palps as well as characters of the apical curvature of the forewing's postmedial line (for details see specific accounts).

Distribution. From India to Sundaland, including Nepal, Myanmar, China, Thailand, Vietnam, Peninsular Malaysia, Sumatra, and Borneo.

***Phocoderma velutina* (Kollar, 1844)**

Figs 1–3, 7, 8, 15, 16, 21, 23–27, 31

Gastropacha velutina Kollar, 1844: 473. Type locality: [north India] “Himal., Massuri”. Holotype: ♀, in NMW.

Natada rugosa Walker, 1855: 1109. Type locality: “Scinde?”. Holotype: ♂, in BMNH. Synonymy established by Butler (1886: 4).

Natada velutina Kollar; Hampson 1892: 382; Hering 1933: 343.

Phocoderma velutina Kollar; Butler 1886: 4; Leech 1899: 103; van Eecke 1925: 27; Holloway 1982: 40, pl. 2 fig. 24; Holloway 1986: 100, pl. 7 figs 163, 164, 168; Holloway 1990: 49, pl. 2 fig. 25; Yoshimoto 1994: 86.

Phocoderma velutinum Kollar; Hering 1931: 720.

Description. Male (Figs 2, 3, 7, 8). Expanse 45–60 mm, forewing length 20–26 mm. Ratio of length of 3rd : 2nd segments of labial palps from 1 : 10 to 1 : 3, and ratio of width of 3rd : 2nd segments from 1 : 6 to 1 : 2.5.

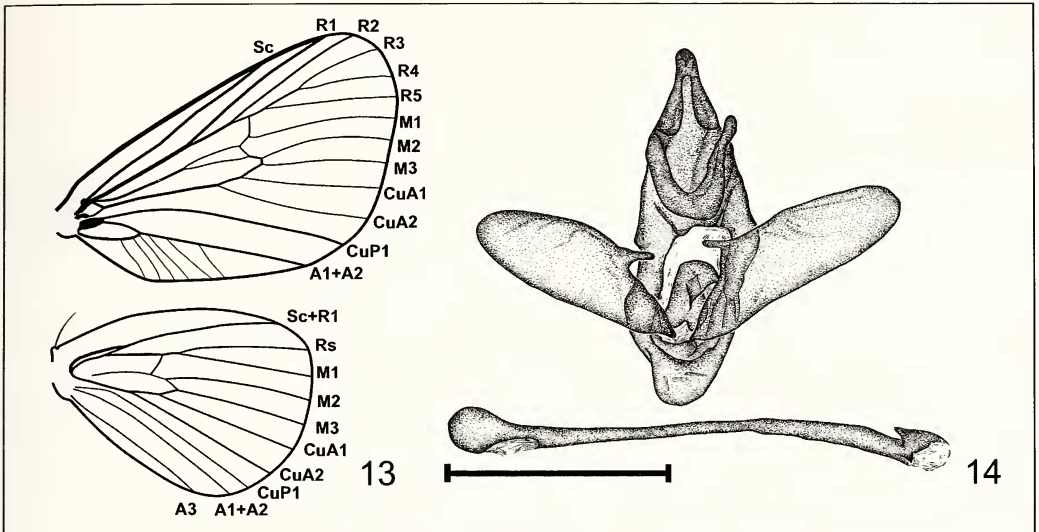


Fig. 13. Wing venation of *Phocoderma velutina* (Kollar); Malaysia, Sabah (Borneo).

Fig. 14. Male genitalia of *Phocoderma witti* sp. n., holotype, GU N° 10008. Scale bar: 5 mm. Apex of phallus oriented to the right.

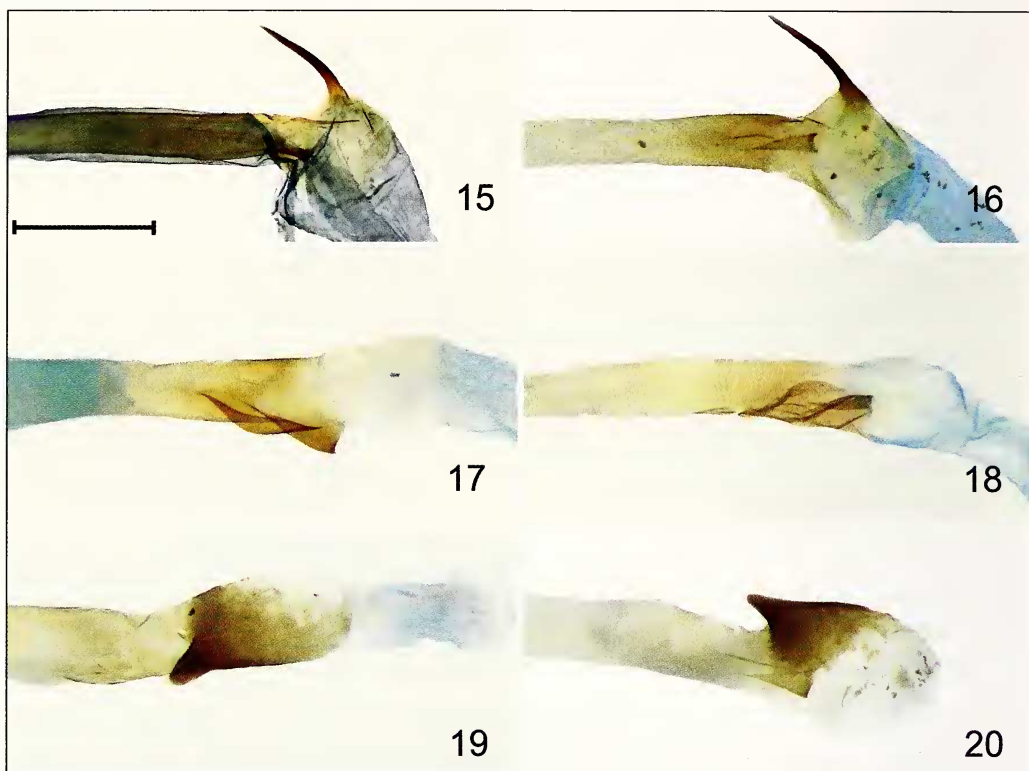
Male genitalia (Figs 15, 16). Uncus narrow with strong sclerotized apex. Gnathos long, strong, with slight curvature. Valvae elongate, of variable shape. Juxta lamellar. Phallus tube-shape, long, very narrow, slightly curved, with long narrow apical process, curved back at 30–40°. Ratio of length of valvae to length of phallus from 1 : 2.3 to 1 : 3.

Female (Fig. 1). Expanse 51–72 mm, forewing length 23–30 mm. Ratio of length of 3rd : 2nd segment of labial palps from 1 : 5 to 1 : 3, and of width of 3rd : 2nd segments from 1 : 7 to 1 : 1.5.

Female genitalia (Figs 21, 23–27). Ductus bursae very long, narrow. Corpus bursae rounded, with diffused linear double signum. Shape of signum variable; ratio of length of maximal width of each half to its length from 1 : 10 to 1 : 5, and of medial width of each half to its length from 1 : 10 to 1 : 5.

Diagnosis. Externally this species is very similar to *P. betis* Druce, but the subapical curvature of the forewing oblique line extending from the wing base to the submarginal fascia is more angular. Also very similar to *P. witti* sp. n., but the 3rd segment of the male labial palp is distinctly shorter than in both other species (see Descriptions). Gnathos strong, narrow, with weak curvature. Phallus longer than in *P. betis*, with narrow, strong and recurved apical process. Signum narrower than in *P. betis*.

Biology. A mature larva is illustrated in colour by Lewvanich (2001: 95, fig. 64). Body with long scoli: length of dorsolateral scoli on segments T3, A1, A7, and A8 about 20 mm at maturity, other dorsolateral scoli 7 mm long, shorter than lateral ones. The ground colour of the body is different tints of green: from yellowish green to pale grayish green, including scoli; lateral and A8 dorsolateral scoli with black tips; scoli situated at intersections of network of transverse and longitudinal bands of ground



Figs 15–20. Apical part of phallus of *Phocoderma* spp. **15.** *P. velutina* (Kollar), holotype of *Natada rugosa* Walker. **16.** *P. velutina* (Kollar); Myanmar, Tenasserim, GU N° 10007 MWM. **17.** *P. betis* Druce; China, Shaanxi, GU N° 9997 MWM. **18.** *P. betis* Druce; China, Yunnan, GU N° 10010 MWM. **19.** *P. witti* sp. n., paratype, GU N° 9995 MWM. **20.** *P. witti* sp. n., holotype, GU N° 10008 MWM. Scale bar: 1 mm.

colour enclosing horizontal blue ellipses dorsally and pale grayish green oblique ellipses laterally on each segment.

The larvae are gregarious when young, living on the underside of leaves, eating the epidermis. They separate on the host-plant when larger and often defoliate whole trees. Pupation occurs on the soil surface in a solid, grey, rough ovoid cocoon (Holloway 1986: 100).

The recorded host-plants are *Lannea*, *Mangifera* (Anacardiaceae), *Sapium* (Euphorbiaceae), *Terminalia* (Combretaceae), *Bombax* (Bombacaceae) (Holloway 1986: 100); *Aleurites* (Euphorbiaceae), *Butea monosperma* (Leguminosae), *Nephelium lappaceum* (Sapindaceae), *Camelia sinensis* (Theaceae) (Robinson et al. 2001: 323).

The flight period is from March to December. The species has been found in habitats situated between altitudes of 150–1900 m and probably is bivoltine.

Distribution (Fig. 31). India, Nepal, Myanmar, Thailand, Malaysia (Taman Negara), Borneo, Sumatra.

Remarks. The synonymy of *P. velutina* (Kollar) and *Natada rugosa* Walker (Fig. 2) is verified on the basis of the external characters of the holotypes, by comparing the locations of their type localities, and by the distribution patterns of all *Phocoderma*

species. Unfortunately, the abdomen of the type specimen of *P. velutina* (Kollar) is strongly damaged (by pests?) and important characters have been lost. A preparation was made and only the ovipositor lobes were found undamaged. The labial palps are also broken. But *rugosa* and *velutina* are the only species of the genus known from north India.

***Phocoderma betis* Druce, 1896**

Figs 4, 5, 9, 10, 17, 18, 22, 28–30, 32

Phocoderma betis Druce, 1896: 236. Type locality: "China, Hunan". Holotype: ♀, in BMNH.

Phocoderma betis Druce; van Eecke 1925: 27; Hering, 1931: 720.

Description. Male (Figs 5, 9, 10). Expanse 42–60 mm, forewing length 20–30 mm. Forewing with subapical curvature of oblique line extending from basal part to submarginal fascia distinctly rounded, never joined with submarginal fascia. Ratio of length of 3rd : 2nd segment of labial palps from 1 : 3.5 to 1 : 1.5, and of width of 3rd : 2nd segments from 1 : 3.5 to 1 : 1.5.

Male genitalia (Figs 17, 18). Uncus narrow. Gnathos long, strong. Valvae elongate. Juxta lamellar. Phallus tube-shaped, long, narrow, slightly curved, with two apical parallel crest-shaped processes, distal crest with short medial point.

Female (Fig. 4). Expanse 55–65 mm, forewing length 28–32 mm. Ratio of length of 3rd: 2nd segment of labial palps 1 : 2 to 1 : 1.5, and of width of 3rd : 2nd segments from 1 : 2 to 1 : 1.5. Ratio of length of valvae to length of phallus from 1 : 2 to 1 : 2.2.

Female genitalia (Figs 22, 29, 30). Ductus bursae very long, narrow. Corpus bursae rounded, with heart-shaped signum variable. Ratio of length of maximum width of lateral part of double signum to its length from 1 : 3.5 to 1 : 3, and medial width of lateral part of double signum to its length from 1 : 5 to 1 : 3.5.

Diagnosis. Forewing pattern characteristic: subapical curvature of oblique line extending from base to submarginal fascia distinctly rounded, much more so than in other two species, never joined with submarginal fascia. Third segment of labial palp in male longer than in *P. velutina* (Kollar), almost as long or a slightly longer than in *P. witti* sp. n. Phallus shorter than in other species, with two parallel crest-shaped apical processes. Signum broader than in *P. velutina* (Kollar), heart-shaped.

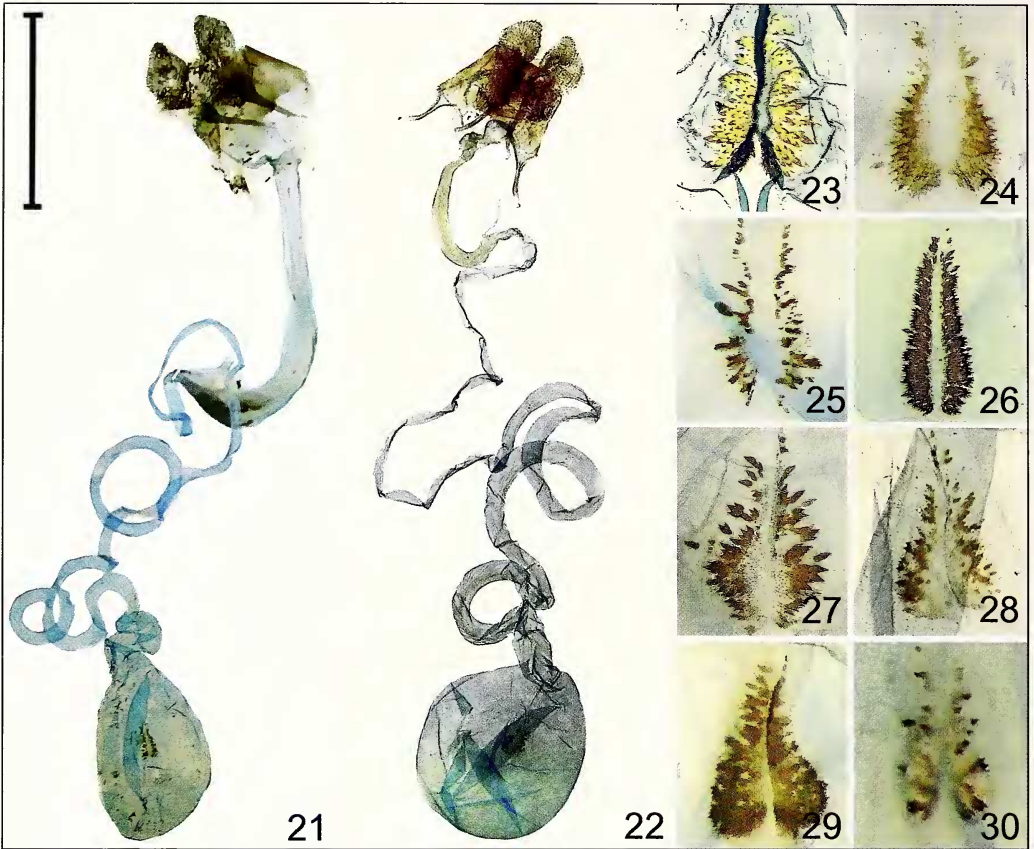
Biology. Little known: flight period from May to September; the species was collected at altitudes of 800–3500 m. The immature stages are unknown.

Distribution (Fig. 32). China (Shaanxi, Hubei, Zhejiang, Sichuan, Hunan, Guanxi, Simao and Yunnan), Northern Thailand (Changwat Nan), Northern Vietnam (Lai Chau).

***Phocoderma witti* sp. n.**

Figs 6, 11, 12, 19, 20, 32

Material. Holotype ♂, 'Myanmar (Burma) | 21 km E Putao | Nan Sa Bon village | 550 m, 1–5.V.1998 | leg. Murzin & Sinjaev | Museum Witt', 'Genitalpräparat | Heterocera | Nr. 10.008 | Museum WITT München', MWM. – Paratypes: 10♂, same data as holotype, 7♂, Myanmar (Burma), Putao, 500 m, 27.iv.1996, leg. Murzin & Sinjaev, MWM (GU Nr. 9995). 3♂, Myanmar N (Burma), Putao, H=500 m, 23.v.1998, leg. V. Murzin, V. Sinjaev, MWM. 7♂, Myanmar (Burma), 65 km NE Putao, Zi Yar Dam



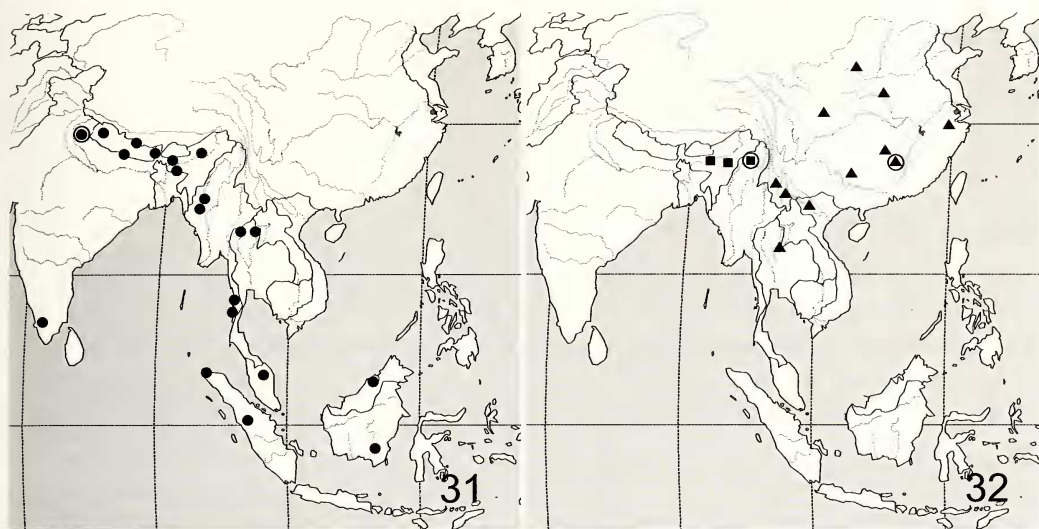
Figs 21–22. Female genitalia of *Phocoderma* spp. **21.** *P. velutina* (Kollar); India, Kerala, GU N° 10013 MWM. **22.** *P. betis* Druce, type. Scale bar: 5 mm.

Figs 23–30. Signum variability of *Phocoderma* spp. **23.** *P. velutina* (Kollar); Sumatra, GU N° 634 JDH of BMNH. **24.** *P. velutina* (Kollar); Nepal, GU N° 10029 MWM. **25.** *P. velutina* (Kollar), GU N° 10002 MWM. **26.** *P. velutina* (Kollar); Myanmar, Tenasserim, GU N° 10003 MWM. **27.** *P. velutina* (Kollar); GU N° 11117 MWM. **28.** *P. betis* Druce, type. **29.** *P. betis* Druce; Thailand, Changwat Nan, GU N° 10001 MWM. **30.** *P. betis* Druce; China, Sichuan, GU N° 11082 MWM.

village, 950 m, 18–21.v.1998, leg. Murzin & Sinjaev, Museum Witt, MWM (GU Nr. 11.127). 1♂, Myanmar (Burma), 16 km E Putao, Kaung Mu Lon village, 500 m, 28–30.iv.1998, leg. Murzin & Sinjaev, MWM (GU Nr. 12.301). 3♂, NE-India, Assam, Nameri Nat. Park, 40 km N Tezpur, 150m, 27°20'N, 93°15'E, 24.vii.–2.viii.1997, leg. Sinjaev & Murzin, MWM (GU Nr. 11.128). 2♂, NE-India, Assam, W. Meghalaya, Garo Hills, Nokrek National Park, 25°40'N, 91°04'E, 1150 m, 2–13.vii.1997, leg. Afonin & Sinjaev, MWM (GU Nr. 10.012 and 11.129). 1♂, Naga Hills, 2500–5000 ft., vi–viii.1889, W. Doherty, ZISP.

Description. Male (Figs 6, 11, 12). Coloration different tints of brown, tanned. Forewing pattern with oblique line extending from basal part to submarginal fascia with distinct curvature. Expanse 45–58 mm, forewing length 20–27 mm. Ratio of length of 3rd : 2nd segment of labial palps from 1 : 3 to 1 : 2.5, and of width of 3rd : 2nd segments from 1 : 3.5 to 1 : 1.5.

Male genitalia (Figs 14, 19, 20). Uncus narrow with strongly sclerotized apex. Gnathos long, strong, curved distally, distinctly hook-shaped. Valvae elongate. Juxta



Figs 31–32. Distribution of *Phocoderma* spp. 31. *P. velutina* (Kollar). 32. *P. betis* Druce (▲) and *P. witti* sp. n. (■). Symbols in a circle represent a type locality.

lamellar. Phallus tube-like, long, very narrow, slightly curved with short, broad, elongate, recurved dorsoapical process. Ratio of length of valvae to length of phallus from 1 : 2.3 to 1 : 3.

Female. Unknown.

Diagnosis. Externally this species is very similar to *P. betis*, but with the forewing subapical curvature of the oblique line extending from the base to the submarginal fascia more angular; without evident external differences with *P. velutina*, but 3rd segment of male labial palps as long or slightly smaller than in *P. betis* and longer and broader than in *P. velutina*. The hook-shaped gnathos and rounded apical process of the phallus are diagnostic; the phallus is longer than in *P. betis*.

Biology. Little known. Flight period from mid April to early August. All specimens were collected at altitudes of 150–1250 m.

Distribution (Fig. 32). North-east of India (Assam, Tezpur, Western Meghalaya), Northern Myanmar (district of Putao).

Etymology. The species is dedicated to Mr. Thomas J. Witt (Munich, Germany) for his constant support of my investigations of limacodid moths.

Conclusions

Genus *Phocoderma* now consists of three species with one of them (*P. witti*) here described as new, while the synonymy of *P. velutina* and *Natada rugosa* was verified.

Phocoderma velutina is the most widespread species of the genus. It is distributed from India and Nepal to Sundaland. In northern Myanmar and east India *velutina* flies in sympatry with *P. witti* and in northern Vietnam with *P. betis*.

The species of *Phocoderma* are very similar externally and the most useful features for species identification are in the male genitalia, especially the shape of the apical processes of the phallus: the single apical process of *P. velutina* is narrow, strong, curved basally; that of *P. betis* is made of two parallel sinusoidal crests; and that of *P. witti* is flat, broad basally, and rounded apically. Some useful external characters for identification were also found: the length of the 3rd segment of the male labial palps and the curvature of the forewing's fasciae.

The values of the ratios between the 3rd and 2nd segments of the labial palps are not discrete and should not be used for final species identification, but they are useful for sorting specimens. Nevertheless, the 3rd segment of the male labial palps in *P. velutina* is shorter than in the other species, while that of *P. betis* is longer, which was found to be unusual and remarkable. The ranges of values of these ratios are without distinct correlation to geographical distribution.

The phylogenetic relationships of *Phocoderma* and other limacodid genera are not clear, but this genus was placed in the "paired signum section" of the family by Holloway (1986: 54). Therefore, it is considered to be close to *Miresa* Walker, *Mahanta* Moore, *Scopelodes* Westwood, *Susica* Walker, and *Hyphorma* Walker.

Phocoderma moths have several unique or rare characters for limacodids. First of all, the length of the 3rd segment of the labial palps is not constant, showing great variability in ratios with the 2nd segment, and it differs in size between and within species. Secondly, the forewing has the medial stem branched distally and six pseudoneuria are present between the anal vein and the dorsal margin. Similar pseudoneuria can also be found in genus *Mahanta* Moore, but in different numbers, and this character can possibly represent a synapomorphy for these two genera.

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